

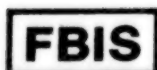
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USSR Report

GEOPHYSICS, ASTRONOMY AND SPACE

No. 450



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USSR REPORT
GEOPHYSICS, ASTRONOMY AND SPACE

No. 450

This serial publication contains articles, abstracts of articles and news items from USSR scientific and technical journals on the specific subjects reflected in the table of contents.

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I. ASTRONOMY

Abstracts of Scientific Articles

CHEMICAL COMPOSITION OF VENUSIAN ATMOSPHERE

Moscow PIS'MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 5, No 5, 1979 pp 217-221

[Article by B. G. Gel'man, V. G. Zolotukhin, N. I. Lamonov, B. V. Levchuk, L. M. Mukhin, D. F. Nenarokov, B. P. Okhotnikov, V. A. Rotin and A. I. Lipatov, Space Research Institute and All-Union Scientific Research Institute of Complex Automation of the Petroleum and Gas Industry, "Analysis of the Chemical Composition of the Venusian Atmosphere Aboard the 'Venera-12' Automatic Interplanetary Station Using a Gas Chromatograph"]

[Abstract] The "Venera-12" automatic interplanetary station carried the "Sigma" gas chromatograph for investigation of the chemical composition of the Venusian atmosphere. A distinguishing characteristic of the "Sigma" chromatograph is the presence of a high-response ionization detector (with a source of beta radiation) based on use of the Penning effect in inert gases. A block diagram of this instrument is shown in Fig. 1 in the text. Analysis of the gas sample and calibration mixture was accomplished in three successive columns and detectors. The instrument and sampling procedure are described in detail. There were eight analyses of the chemical composition of the Venusian atmosphere, beginning with an altitude of 42 km to the planetary surface. Nitrogen was discovered in a concentration $2.5 \pm 0.5\%$ by volume; argon was in a concentration $(4 \pm 2) \cdot 10^{-3}\%$ by volume; CO -- $(2.8 \pm 1.4) \cdot 10^{-3}\%$ by volume; and SO₂ in a concentration $(1.3 \pm 0.6) \cdot 10^{-2}\%$ by volume. The authors were able to estimate the upper limits for the content of oxygen and water vapor, equal to $2 \cdot 10^{-3}$ and $10^{-2}\%$ by volume respectively.

[428]

PHOTOMETRY OF CLOUD FORMATIONS ON MARS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 13, No 2, 1979 pp 87-93

[Article by V. A. Fenchak, Crimean Astrophysical Observatory, "Photometry of Cloud Formations on Mars on Television Photographs for the Period 4 August to 5 September 1971"]

[Abstract] A study was made of the photometric characteristics of cloud formations on Mars in dependence on wavelength and time during a period preceding the formation of a global dust storm on Mars. The photometric study was made using photographs of Mars taken at the Crimean Astrophysical Observatory using highly sensitive television apparatus in four parts of the spectrum (λ_{eff} 377, 448, 546, 642 nm). Registry of the image was on fine-grain film with an exposure of 1 sec. During a night several series of television photographs were obtained with an interval of 0.5-1.5 hours. All the negatives were photometrically calibrated using a special attenuator giving 24 intensity gradations. Fifty to twenty identical Martian photographs were examined for selecting the one of the best quality for photometric processing. A total of 300 photographs were selected (75 series). These data were used in compiling isophot maps of the Martian disk. This made it possible to determine the ratio of the brightness of the cloud formation over a light region to the brightness of the light regions free of clouds. The photometric results of Martian cloud formations are graphically represented in Figures 3 and 5 in the text. These reveal the presence of both dust and violet clouds, whose behavior is discussed in detail.

[417]

PROBLEMS IN PLANETARY COSMOGONY REVIEWED

Moscow ZEMLYA I VSELENNAYA in Russian No 3, 1979 pp 2-6

[Article by B. Yu. Levin, "Problems in Planetary Cosmogony"]

[Abstract] Until the middle of this century planetary cosmogony was considered a purely astronomical problem. But in the 1940's O. Yu. Shmidt emphasized that planetary cosmogony had become an astronomical-geophysical problem. The coming of the space era greatly reinforced this reality and current progress in planetary cosmogony is the work not only of astronomers, but also geologists, mineralogists, petrologists, space chemists, and others. This concise review examines the most current conclusions drawn concerning the accumulation of the planets, origin of the protoplanetary cloud, dust in the protoplanetary cloud, origin and evolution of the moon, and where primary matter can be found. The latter problem is considered particularly important for a further advance in planetary cosmogony. It seems improbable that the launching of a spacecraft to any asteroid would yield any results which would be a key

to solution of fundamental problems. It is far too early to think of return of a fragment of an asteroid to the earth. But even if this could be done, the probability is that the material would be closely related to or identical to already studied meteorites. Far more promising is the launching of a spacecraft to a comet. The ice nuclei of comets are the bodies with whose accumulation the formation of the giant planets began. Precisely because stony-ice cometary nuclei have always remained cold, their matter to the greatest degree has retained the properties acquired during formation of the planetary system. Present-day knowledge concerning the structure and composition of cometary nuclei is incomparably poorer than concerning asteroids. It is therefore very important to obtain at least photographs of the surface of a cometary nucleus from a close distance and make an approximate analysis of its composition. Such investigations will provide additional data which can be used in theoretical investigations.

[421]

CHARGE SPECTRUM AND COMPOSITION OF PARTICLES ACCELERATED IN FLARES

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 56, No 3, 1979 pp 574-583

[Article by A. A. Korchak and B. P. Fillipov, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Formation of the Charge Spectrum and Composition of Particles Accelerated During Solar Flares"]

[Abstract] The authors analyze selectivity relative to charge and mass for the four most probable mechanisms of acceleration during solar flares (Fermi, betatron, acceleration by an electric field and Langmuir waves), and also the influence of collisions on the charge spectrum and composition of particles. It is shown that there can be a qualitative explanation of the composition of solar cosmic rays by the action of two mechanisms in different parts of the acceleration region, one of which is characterized by a very high intensity and is operative directly during the time of the flash phase of a flare, whereas the other, considerably slower, is operative up to the flash phase. The action of the latter leads to an accumulation of heavy particles in the low-energy region. The influence of the collision of particles with protons and the role of the proton maximum of losses were investigated. Also considered are the conditions for setting-in of an equilibrium charge of the accelerating particles.

[450]

DYNAMIC SPECTRA OF TYPE-V SOLAR RADIO BURSTS

Moscow ASTRONOMICHSKIY ZHURNAL in Russian Vol 56, No 3, 1979 pp 549-561

[Article by L. M. Bakunin, A. K. Markeyev, V. V. Fomichev and I. M. Chertok, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Characteristics of Dynamic Spectra of Type-V Solar Radio Bursts"]

[Abstract] The authors made a detailed analysis of the characteristics of the dynamic spectrum of type-V bursts, in particular, the general form of the spectrum, the fine structure and harmonic structure of these phenomena. The analysis is based on data for approximately 120 type-V bursts registered at the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation during the period 1967-1976 using a spectrograph covering the frequency range 45-90 MHz. The minimum detectable flux density is $\sim 5 \cdot 10^{-21} \text{ W} \cdot \text{m}^{-2} \cdot \text{cps}^{-1}$ and the frequency and time resolutions are 0.3 MHz and 0.2 sec respectively. The article gives an analysis of phenomena representing continuous emission with a total duration of not less than 25-30 sec. It was found that there is a great diversity and complexity of the dynamic spectra of these phenomena. There are a number of categories of bursts with a different character of emission on the leading and trailing edges. On the dynamic spectra of many bursts there are a number of kinds of fine structure. An analysis of type-V bursts is given; there is a clear manifestation of emission at the frequency of the fundamental tone and the second harmonic. At present it is difficult to explain fully the diversity and complexity of the dynamic spectra of type-V bursts. It can only be postulated that the peculiarities of the general form of the spectrum are governed by the different conditions of injection and the dynamics of motion of fast electrons in magnetic traps, and accordingly, by the different conditions for the formation of emission sources at different levels in the corona.

[450]

REVIEW OF PROPERTIES OF INTERPLANETARY PLASMA

Moscow GEOMAGNETIZM I AFRONOMIYA in Russian Vol 19, No 3, 1979 pp 401-424

[Article by V. I. Vlasov, I. V. Chashey, V. I. Shishov and T. D. Shishova, "Interplanetary Plasma Studied by Radioastronomical Data"]

[Abstract] This review of the properties of interplanetary plasma as determined from radioastronomical data is based on exploitation of the 153 sources cited in the bibliography. The following is the outline of the review: Theoretical principles of method; Scattering of radio waves; Scintillations of radio sources; Measurements of velocity of interplanetary plasma; Turbulence spectra for interplanetary plasma; Nature of turbulence in interplanetary plasma; Large-scale structure of interplanetary plasma; Large-scale inhomogeneous structure and nonstationary processes in interplanetary plasma; Correlation with solar activity and geophysical phenomena. The review clearly

shows that recently considerable successes have been attained in this field: there has been clarification of the form of the turbulence spectrum in the high-frequency field, a mean model of the distribution of turbulent plasma and solar wind velocity in interplanetary space was determined. As a result of observations it is now possible to obtain the pattern of distribution of interplanetary plasma as a whole. However, radioastronomical investigations of interplanetary plasma can still solve many other problems: 1) The nature of inhomogeneities in the interplanetary magnetic field (IMF). There is a conspicuous lag in theory in this field. There is also an inadequacy of observational data on the internal and external scales of turbulence. 2) The mechanism of solar wind acceleration. There must be systematic measurements of velocity of the solar wind and other parameters of the IMF at a distance $\sim (1-30)R_{\odot}$. Large-scale inhomogeneous structure of the IMF (shock waves, accelerated streams, etc.). There must be systematic mapping of interplanetary plasma over a period of a half-year or more. This problem is closely related to the problem of use of IMF observations for predicting geophysical manifestations of solar activity.

[449]

RELATIONSHIP BETWEEN GEOMAGNETIC STORM AND PASSAGE OF FLARE STREAM

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 19, No 3, 1979 pp. 449-451

[Article by N. V. Mikerina, A. V. Belov and K. G. Ivanov, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Geomagnetic Storm and Variations of Galactic Cosmic Rays During Passage of Flare Stream With a Complex Hydromagnetic Structure"]

[Abstract] There are at least 17 modifications of structure of an isolated flare stream. The superposing of streams from two or more flares gives rise to complex structures with an enormous number of modifications. In this paper, on the basis of detailed observations of the magnetic field made with the "Explorer-35" during the period 28-29 October 1968, a study is made of the complex interplanetary structure generated by a series of four flares and some of the geophysical effects caused by this structure. Four shock fronts in the interplanetary magnetic field were identified with four flares situated in the southern part of the sun's eastern hemisphere. The described structure caused an unusual geomagnetic disturbance at the earth's surface and a disturbance in cosmic rays. In particular, at all middle-latitude observatories the magnetic storm was represented by an alternation of relatively quiet sectors and substorms (presence in magnetic region and presence in shock layer). This analysis of structure of the stream and geomagnetic disturbance shows that a knowledge of the detailed structure of the stream and field behavior and plasma characteristics makes it possible to understand the origin of each variation in a geomagnetic storm, however complex it may seem.

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II. OCEANOGRAPHY

News

"PISCES" VESSEL USED IN 22ND "MENDELEYEV" EXPEDITION

Moscow Domestic Service in Russian 1530 GMT 20 Jun 79

[Editorial Report] The USSR Academy of Sciences' Institute of Oceanology imeni Shirshov has reported that its laboratories are now processing data obtained during the 22nd voyage of the "Dmitriy Mendeleyev" scientific research vessel. This expedition was the first to make extensive use of the "Pisces" deep sea submersible.

According to the report, the quality and precision of deep sea measurements have greatly increased inasmuch as the "Pisces" vessel is not physically connected to the surface vessel. The submersible reached a maximum depth of 1,720 meters in 2.5 hours in the Timor Sea -- a record for this type of apparatus.

Scientists are now preparing for a new expedition in the Red Sea to begin at the end of this year. Its purpose is to study continental drift. [5]
[441]

RESEARCH VESSEL ON NEW EXPEDITION

Moscow PRAVDA in Russian 11 Jun 79 p 6

[Brief] Again the scientific research ship "Akademik Kurchatov" has sailed into the Atlantic. The purpose of this expedition is to continue research in accordance with the international program to study the interaction of the ocean and the atmosphere. Observations will be made using buoy stations.
[426]

Translations

EARTH'S CRUST UNDER THE OCEANS

Moscow PRIRODA in Russian No 4, 1979 pp 42-47

[Article by G. B. Rundnik and G. L. Kashintsev]



Grigoriy Borisovich Rudnik, Candidate of Geological-Mineralogical Sciences, senior scientific specialist at the Institute of Oceanology imeni P. P. Shirshov USSR Academy of Sciences. Engaged in study of the petrology of magmatic rocks in the ocean. (at right) Georgiy Leonidovich Kashintsev, Candidate of Geological-Mineralogical Sciences, junior scientific specialist at the same institute. Engaged in study of petrology of magmatic rocks in the ocean.

[Text] Before our very eyes geology is undergoing a radical restructuring associated with its transformation from the science of the earth's crust to the history of development of the earth's entire upper shell, including regions covered by the waters of the world ocean.

The earth's crust under the oceans differs from the earth's crust on the con-

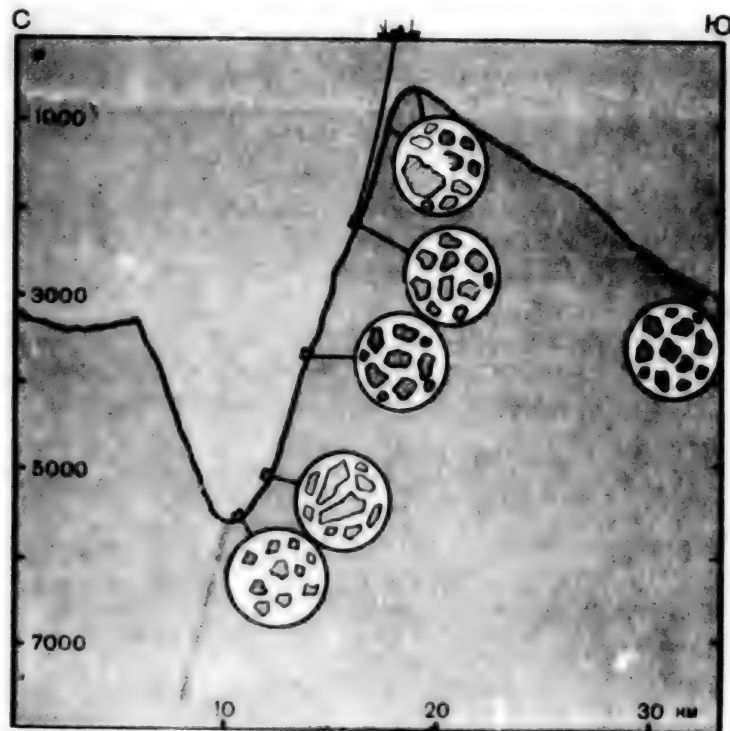
Under the relatively thin first sedimentary layer, characterized by velocities of elastic waves 1.5-3.0 km/sec, there is a second layer. The composition of its rocks, judging from the velocity characteristics (3.5-6.4 km/sec), must be close to compacted sediments or volcanogenic basaltic strata. The thickness of this layer averages 1.5 km. Still lower there is a five-kilometer third layer with velocities of longitudinal waves 6.6-7.2 km/sec, conventionally called the "basalt" layer and consisting, presumably, of crystalline basic rocks of the gabbro type. Other variants of composition of the third layer have also been proposed. At one time the hypothesis of H. Hess was very popular. He postulated a serpentine nature of this layer, arising as a result of hydration of olivine in peridotites in the upper mantle, rising in the process of spreading of the sea floor. In the opinion of a number of other sea researchers, the third layer was formed of metamorphosed basalts and amphibolites.

The three main layers discriminated by geophysicists form the so-called normal section of the oceanic crust, beneath which lie dense ultrabasic rocks of the upper mantle (or the fourth layer), characterized by seismic velocities of 7.7-8.2 km/sec.

Thus, the earth's crust under the oceans could be divided into layers, but the question as to what rocks form the bottom of the section has remained open. Earlier the composition of layers was judged on the basis of a comparison of seismic data with the velocity characteristics of different rocks measured under laboratory conditions. This interpretation to a considerable degree is of an arbitrary character, since many rocks of different composition are characterized by close velocity characteristics, and on the other hand, one and the same rocks, but subjected to metamorphism, fragmentation or other effects, can differ considerably with respect to the velocities of seismic wave propagation.

We began to receive direct information on the rocks of deep horizons relatively recently, using the methods of drilling of the ocean floor and detailed horizon-by-horizon sampling by means of dredges, as well as sampling from natural exposures of rocks on the sea floor by deep-water self-propelled vehicles.

Each of these methods, in addition to its merits, has its negative aspects. In the case of drilling, there are technical difficulties, because it is necessary to drill at enormous depths in the ocean. The international deep drilling project has already been in progress for several years. By mid-1978 more than 450 boreholes had been drilled in the ocean floor from the scientific research ship "Glomar Challenger." At a maximum depth the drill penetrated in the equatorial Atlantic to a depth of 676 m (borehole 395) and in the southern end of the Bermuda Rise to a depth of 868 m (borehole 413). In these boreholes it was possible to obtain material of enormous scientific value, but the deep horizons of interest to us have not been reached.

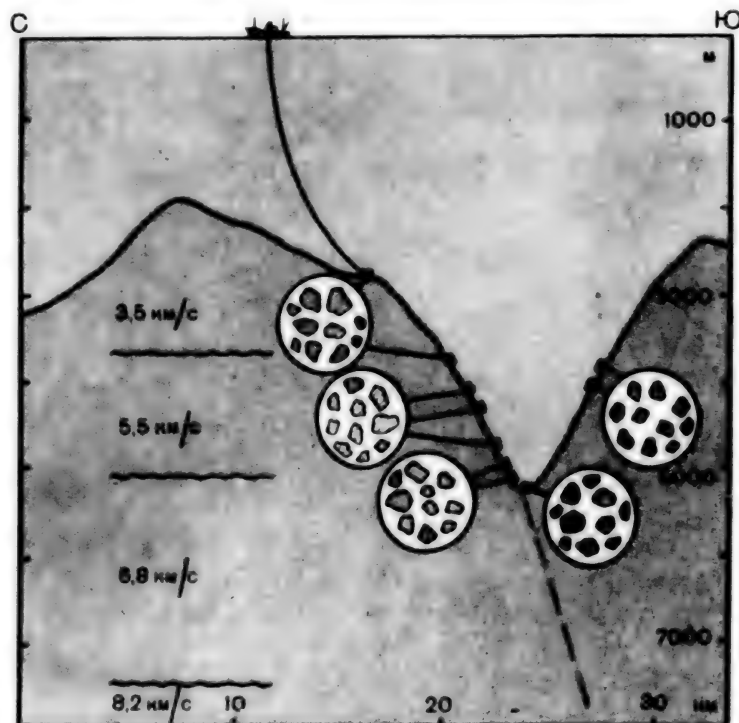


Schematic profile through Heezen fault (zone of Eltanin faults in southeastern part of Pacific Ocean). The amphibolites and ultrabasic rocks on the lower part of the slope are replaced by gabbros, dolerites and basalts on the upper part of the slope. (North at left and south at right.)

In the drilling of borehole 418 the problem was to determine the composition of the upper part of the second layer, having seismic velocities of 3.5-4.5 km/sec, and its denser lower part with velocities of longitudinal seismic waves of 5.5-6 km/sec. It was necessary to clarify what is responsible for the increase in velocities in the lower part of the second layer: due to a decrease in the interlayers of sedimentary and unconsolidated volcanogenic rocks in basalts or due to an increase in the denser subvolcanic (that is, solidified material not reaching the surface) bodies, cutting through the layers of basaltic lavas or penetrating through their bedding. Despite the great depth of penetration into the second layer, borehole 418 virtually did not go beyond its upper part. Accordingly, at the present time, until there is a further improvement in the technology of underwater drilling, this method will not yield information on the structure of deep horizons in the oceanic crust.

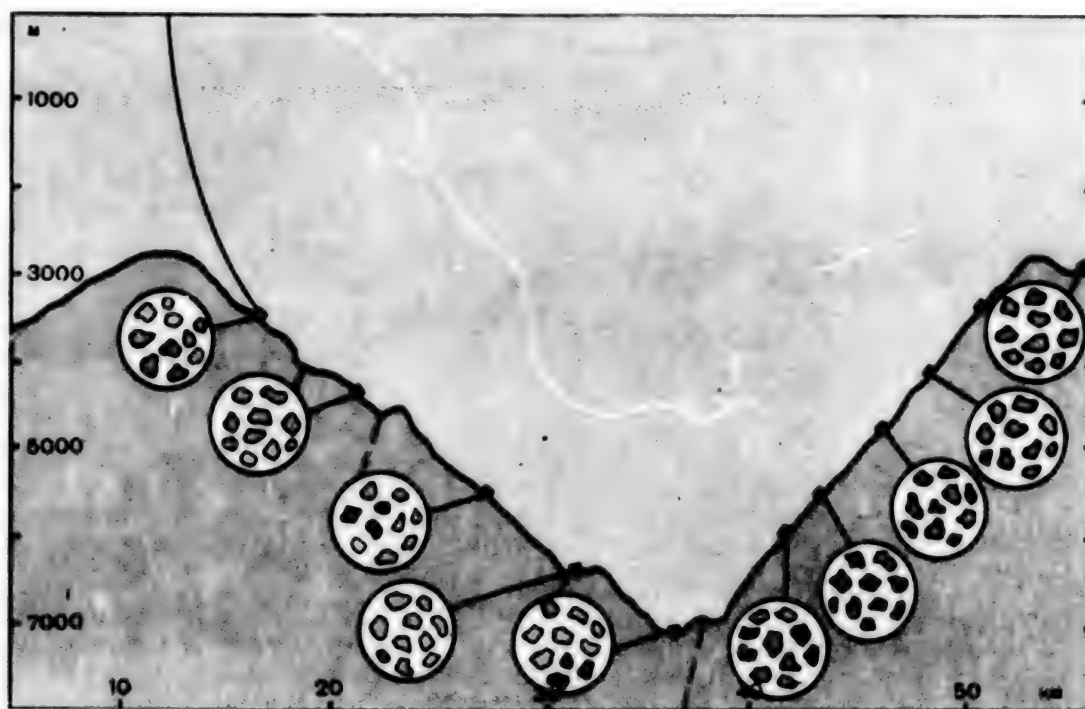
Therefore, a method which is very important is the successive dredging of steep multikilometer scarps formed by tectonic faults. Naturally, detailed sampling of rock exposures on the ocean floor, concealed beneath the ocean waters, is no simple problem. One of the principal difficulties in this sort of work is the complexity in obtaining a precise spatial tie-in of the rock

samples raised from the floor. This is related to the very essence of the dredging method, involving the lowering of dredging gear on a long multi-kilometer cable. Now the most frequently used dredge is a metal cyclinder with a diameter of 0.7-1.0 m with a toothed cutting edge. A multilayered meshwork bag for holding the collected rock samples is attached to the rear parts of the dredge.



Schematic profile through the Hess depression, an active zone of recent spreading of the ocean floor in the eastern part of the Pacific Ocean. On the northern edge of the depression there is a successive change in rocks from gabbros in the lower part of the slope to dolerites and basalts in the upper part. The boundaries between layers with different velocities of seismic waves are shown at the left of the figure. These boundaries were determined as a result of deep seismic sounding of the investigated region. It is easy to see coincidence of geophysical layers with a predominance of different kinds of rocks at the corresponding depths.

The dredging process is controlled from aboard the scientific ship by means of an automatic echo sounder which continuously plots the bottom relief beneath the ship. The movement of the dredge along the bottom is accomplished for the most part by means of the ship's drift. The maximum accuracy in the tie-in of rock samples obtained in this process is ± 100 m in depth. This accuracy is entirely adequate for constructing general geological sections. But for more detailed sections this accuracy can be increased by using



осадки
 базальты
 долериты

габбро
 перидотиты
 зеленые сланцы
 амфиболиты
 гранулиты
 разломы

Schematic geological profile of Romanche fault in the Atlantic Ocean prepared using data from Soviet and foreign expeditions. (The symbols are the same for the three figures.) On the southern slope there is a predominance of deep ultrabasic rocks, whereas on the northern slope in all depth intervals there is a predominance of both ultrabasic and basic varieties of rocks characteristic of different layers of the ocean crust.

sediments
 basalts
 dolerites

gabbros
 peridotites
 greenstones
 amphibolites
 granulites
 faults

automatic depth recorders attached to the dredge or pingers, instruments sending to the echo sounder signals indicating the precise position of the dredge.

Great possibilities for study of geology of the ocean floors are being afforded by the use of self-contained manned deep-water vehicles outfitted with manipulators for the taking of samples.

We are by no means just beginning work on study of the geological structure of the ocean crust. At the present time oceanologists have schematic sections of the earth's crust under the ocean obtained in different regions of the earth. Such sections have been constructed, for example, on the basis of materials from the dredging of scarps in Atlantic faults and in abyssal trenches. The most detailed investigations have been made in the Vema and Romanche faults (equatorial Atlantic). These major faults are characterized by complex, stressed tectonics, causing considerable block movements of the crust. In bottom relief they are expressed by deep depressions with relatively gentle slopes complicated by small grabenlike rises and scarps. The southern slopes of the depressions almost to the top consist of serpentinites, rocks of the deep horizons rising due to vertical block movements.

It is usually assumed that on the northern slopes there is a normal section of the ocean crust. Here, as a result of numerous dredgings, it was possible to bring to the surface basalts, metabasalts, gabbros, metagabbros and serpentinites. However, it has not been possible to obtain the distribution of rocks by layers which follows from the seismic model of structure of the oceanic crust. The absence of such a stratification is possibly attributable to the fact that here, not only on the southern, but also on the northern slopes of the valleys, there have been complex tectonic movements of rock masses disrupting their initial bedding.

Thus, the choice of faults in the equatorial Atlantic as objects for study of the patterns of structure of the oceanic crust (especially its deep horizons) was scarcely the best. Evidently, for solving this problem we must select fault structures with steeper V-shaped valleys, great height differentials on the steep slopes and less complex block tectonics. The Eltanin and Galapagos faults were precisely such structures; these are situated on the East Pacific Ocean Rise.

A geological-geophysical study of the Eltanin faults was carried out on the 24th voyage of the scientific research vessel "Akademik Kurchatov." (For further details see PRIRODA, No 2, pp 151-153, 1978.) One of the morphologically best expressed sectors of this zone, the Heezen depression, is a narrow, V-shaped valley with a height of the southern slope of about 5 km. On this slope there have been successive dredgings from the foot to the upper brow.

Large sharp-angled blocks of amphibolitic schists were raised by dredge from the maximum depths (5200-5600 m); these are rocks forming due to changes in the course of metamorphism of oceanic basalts. The thin-banded

picture of these schists makes it possible to see that they had been bent into fine twisted folds. Serpentinized ultrabasic rocks and a small quantity of rocks forming in the high-temperature stages of metamorphism, granulites, were dredged along the valley slope, at depths of 3900-4000 m. Still higher, in the depth range 1800-2000 m, gabbroids were extracted, and from a depth of 1000 m -- dolerites and basalts. The uppermost part of the southern slope consisted of oceanic basalts, together with which limestones, fragments of dead coral and mollusk shells were discovered here.

Thus, in the Eltanin zone of faults material was collected which makes it possible to construct a layer-by-layer, although extremely schematic, cross section of the oceanic crust to a depth of about 5 km.

A more detailed geological section was obtained in the Hess depression, situated in the western part of the Galapagos fault in the equatorial part of the Pacific Ocean. This depression, formed by recent spreading of the ocean floor, at the junction of three lithospheric plates (Pacific Ocean, Nazca and Cocos), is characterized by a valley of a V-shaped configuration, with steep slopes and elevation differences of 3000 m.

The Hess depression was studied on three expeditions of Soviet scientific research vessels (8th, 14th voyages of the "Dmitriy Mendeleev" and the 24th voyage of the "Akademik Kurchatov"), during which sufficiently representative material was collected on its slopes. Deep seismic sounding was carried out on the northern margin of the depression. This enabled Yu. P. Neprochnov to construct a geophysical section of the earth's crust for this sector, correlating well with the results of geological sampling.

In this section the upper layer with velocities of seismic waves 3.5 km/sec consisted of spherulitic lavas of basalts. The thickness of this layer is about 800 m; it evidently can be greater under individual volcanic structures.

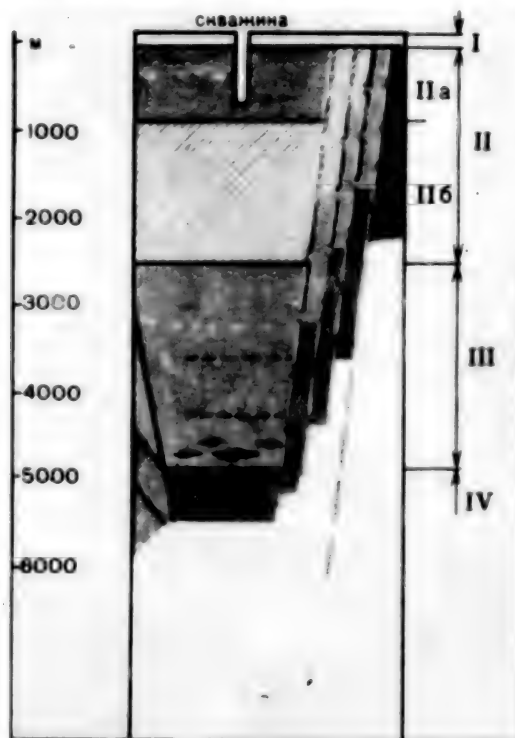
Underneath there is a layer with velocities 5.5 km/sec in which there is a predominance of subvolcanic facies of basalts-dolerites. The thickness of this layer is about 1.5 km. A petrographic study of its rocks indicated that here there are transitional varieties from microdolerites to large-grained gabbro-dolerites. Such sets of rocks are characterized by quite thick basaltic bodies solidifying at a small depth -- sills or dikes.

Thus, in the second layer it is possible to discriminate an upper part, consisting of spherulitic lavas, and a lower part, in which together with lavas there is broad development of denser subvolcanic rocks.

Beneath these rocks on the northern margin of the Hess depression there is a seismic horizon with a thickness of 2.5-3 km with velocity characteristics typical of the third layer in the earth's crust (6.8 km/sec). The rocks raised by dredges from this layer were banded gabbros of different

composition in which individual layers are enriched with olivine as far as the formation of plagioclase olivinites. This gives basis for assuming that still deeper horizons consist of ultrabasic rocks with a great amount of olivine.

On the basis of generalization of all the considered material we can propose the following composite section of the earth's crust for the region of the mid-oceanic ridges. Under the rather thin first layer of sediments there is a second layer which can be broken down into a less dense upper sublayer, consisting of spherulitic lavas and lava breccias (in a number of cases with a small number of layers of sedimentary rocks) and a lower sublayer in which numerous dikes and sills of subvolcanic dolerites have penetrated into the basaltic covers. The third layer of the oceanic crust consists primarily of gabbroids -- deep analogues of basalts. In its lower part there can be ultrabasic rocks, and also metamorphic rocks -- amphibolites and greenstones. The fourth layer consists primarily of ultrabasic rocks, together with which there are metamorphic rocks -- amphibolites and granulites.



Schematic composite section of oceanic crust in major tectonic faults associated with zones of active spreading of the ocean floor. The right part of the figure shows those parts of the crust where there were block movements of its lower layers (for example, faults in the Atlantic). The Roman numerals denote layers consisting of different rocks (IIa, IIb -- upper and lower parts of the second layer). Annotation at top: borehole

In regions of increased tectonic activity, such as the major faults of the equatorial Atlantic, this successive bedding of rocks is disrupted by block or overthrust movements moving the rocks of the lower horizons to higher levels. This applies, in particular, to ultrabasic rocks, transformed in the process of metamorphism into serpentinites, which by virtue of their high plasticity are capable of being squeezed upward easily. In this connection serpentinites are frequently encountered in the upper horizons of the oceanic crystalline basement, as is observed on the southern margin of the Romanche depression.

The sections of the oceanic crust were also studied from underwater exposures in abyssal trenches which are situated on the margins of the oceans, along the island arcs. The same magmatic rocks were raised from the oceanic slopes of the trenches as are encountered in the faults of the mid-oceanic ridges. The difference in the geological structure of these structures is a greater thickness of the individual layers exposed on the slopes of the trenches and also the more varied composition of the sedimentary stratum making up the first layer. Evidently, depending on the duration of volcanic activity in any particular region of the ocean, and also on the volume of the magma emanating from the earth's depths, the thickness of its magmatic layers can vary.

At the same time, the oceanic crust over the greater part of its area consists of a rather uniform range of rocks of a primarily ultrabasic and basic composition. This composition of the rocks corresponds to the earlier stages in the development of the earth's crust in comparison with the continents, where a considerable volume is occupied by acidic, granitic and metamorphic rocks.

It is possible that in local regions of the oceans there are crustal blocks similar in structure to the continental crust, but for the time being the study of oceanic rocks has not given oceanologists proof of the existence of such blocks.

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III. TERRESTRIAL GEOPHYSICS

Abstracts of Scientific Articles

HEAT FIELD IN THE CASPIAN DEPRESSION

Moscow GEOTEKTONIKA in Russian No 3, 1979 pp 97-102

[Article by M. D. Khutorskoy, Geological Institute USSR Academy of Sciences, "Characteristics of the Heat Field in the Eastern Part of the Caspian Depression"]

[Abstract] The eastern part of the Caspian Depression is characterized by the presence of thick (up to 4 km) layers of salt rocks deposited in the Kungurian and as a result of tectonic and gravitational instability assuming the form of domes and plugs. A peculiarity of rock salt is its high heat conductivity in comparison with the surrounding rocks. The heat conductivity of salt is 13-16 mcal/cm·sec·degree and the heat conductivity of the surrounding rocks (argillites, aleurolites) is 4-5 mcal/cm·sec·degree. In rocks with different thermophysical properties there is a heat flow perturbation. In strata with an increased heat conductivity it increases, whereas in strata with a low heat conductivity it decreases. Under salt tectonics conditions there is a redistribution of the heat flow and due to this a curvature of the deep isotherms. Numerous investigations have revealed a complex nature of geotemperature conditions in these regions. The author here examines the necessity for computing the horizontal and vertical components of the heat flow under contrasting heat conductivity conditions. The article gives the results of analog modeling of the heat conductivity processes under salt tectonics conditions. It is shown that there is a discrepancy in determination of the depth of isotherms when structural distortions are taken into account and when they are not. A method is presented which makes it easy to compute the deep heat flow from measurements in a borehole drilled in any part of a salt dome and beyond its limits. It was determined that the process of heat conductivity in the region of development of salt structures in the eastern part of the Caspian Depression is stationary, beginning with the Jurassic, and disruptions in stationarity in any case disappear relatively rapidly.

[430]

GRAVITATIONAL MODELING OF GRADIENT-LAYERED CRUSTAL STRUCTURES

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ZEMLI in Russian No 6, 1979
pp 38-51

[Article by S. S. Krasovskiy, Geophysical Institute, Ukrainian Academy of Sciences, "Gravitational Modeling of Gradient-Layered Structures in the Earth's Crust"]

[Abstract] An analysis of geological-geophysical materials indicates that the earth's crust is characterized by a gradient-layered increase in density with depth and the presence of a transition zone between the earth's crust and the upper mantle. The author proposes that gravitational modeling not be carried out with the traditional representation of the earth's crust in the form of "granite" and "basalt" layers with constant densities and a jumplike density change at well-defined Conrad and Mohorovicic discontinuities, but for gradient-layered media. The method of three-dimensional iterative modeling developed by the author was found to be effective in investigations along a number of deep seismic sounding profiles in the Ukraine and can be recommended for use in other regions.

[455]

DETERMINATION OF SURFACE WAVE REFLECTION AND REFRACTION COEFFICIENTS

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ZEMLI in Russian No 6, 1979
pp 11-21

[Article by Ye. N. Its and T. B. Yanovskaya, Leningrad State University, "Determination of the Coefficients of Reflection and Refraction of Surface Waves on a Vertical Contact Using Green's Functions"]

[Abstract] The problem of reflection and refraction of surface waves on a vertical boundary still does not have a precise solution. This is attributable to the fact that with the incidence of a surface wave on a discontinuity there is also formation of waves of the body type, which it is exceedingly difficult to take into account. Therefore, approximate methods have been developed for computing the fields of reflected and refracted surface waves in which the body waves forming on a discontinuity are neglected. In an earlier study (T. B. Yanovskaya, et al., VYCHISL. SEYSMOLOGIYA, No 9, Moscow, "Nauka," 1976) it was proposed that use be made of a method based on the Huygens-Fresnel principle in determining fields of both transmitted and reflected waves. It is assumed that the source for formation of the transmitted wave is the total field formed on the boundary of the incident and reflected waves, whereas the source for formation of the reflected wave is the difference of the fields in the incident and transmitted waves. In the case of normal incidence of a Rayleigh or Love wave this approach can

be rather simple. But in the case of slant incidence the approach becomes extremely complex and it is more convenient to use the mathematical formalism of the Green's functions method. The article describes the use of the Green's functions method for solving the problem of reflection and refraction of a surface wave in the case of slant incidence on a vertical discontinuity of vertically inhomogeneous quarter-spaces. The authors derive a system of equations for determining the reflection and refraction coefficients. This system is equivalent to that which is obtained from the condition of stationarity of the energy of the body waves forming on such a discontinuity.

[455]

ENVELOPES OF SEISMIC CODA AND EVALUATION OF EARTHQUAKE MAGNITUDE

Moscow IZVESTIYA AKADEMII NAUK SSSR, FIZIKA ZEMLI in Russian No 6, 1979
pp 22-29

[Article by T. G. Rautian, V. I. Khalturin and I. S. Shengeliya, Institute of Physics of the Earth and Geophysics Institute, Georgian Academy of Sciences, "Envelopes of Seismic Coda and Evaluation of Magnitude of Caucasian Earthquakes"]

[Abstract] A study was made of the form of the coda envelope on the basis of records obtained using SKM-3 apparatus. It was found that the envelopes of coda records from Caucasian earthquakes are very stable in form. Available data failed to reveal significant local deviations and no stationary differences were observed. The scatter of measurements of coda amplitudes relative to the generalized curve is about 20-30%. The form of the envelopes is not dependent on epicentral distance and magnitude. The coda amplitudes increase with magnitude and in the interval of change in magnitudes from 0.3 to 5.7 there is satisfaction of the expression $\lg A_{100} = M - 4.05$. On the basis of this expression and a generalized coda envelope it was possible to construct a nomogram for determining magnitudes from segments of the coda envelopes. In this case the accuracy in determining magnitude on the basis of data for one station is no worse than in the ordinary determination of magnitude on the basis of direct waves measured using data from the network of stations. The method is indispensable in a case when direct waves for some reason have not been registered. The proposed nomogram can be used for the classification of earthquakes in the Caucasian region on the basis of records of stations equipped with SKM-3 instruments. The level and the form of the coda envelope are highly dependent on frequency and vary from region to region.

[455]

NEW APPROACH TO STUDY OF RECENT CRUSTAL MOVEMENTS

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 3, 1979 pp 3-12

[Article by E. E. Fotiadi and N. P. Yesikov, Institute of Geology and Geophysics, Siberian Department USSR Academy of Sciences, "New Approach to Use of Geodetic Data on Recent Crustal Movements"]

[Abstract] The article discusses new approaches in the analysis and interpretation of geodetic data on recent crustal movements for the purpose of increasing the effectiveness of solution of a number of geological-geophysical problems, including study of seismicity, volcanic activity, etc. It is shown that invariance principles, deformation theory and finite-element approximations constitute the methodological basis which makes it possible to obtain new information on the problem of movements of the crust and to increase the yield of information from expensive geodetic methods for learning the regularities in structure and development of the earth's crust.

[422]

MORPHOLOGY OF ABYSSAL TRENCHES AND "BENIOFF ZONES" PROBLEM

Moscow BYULLETEN' MOSKOVSKOGO OBNCHESTVA ISPITATELEY PRIRODY, OTDEL GEOLOGICHESKIY in Russian Vol 54, No 3, 1979 pp 81-91

[Article by A. A. Pronin, "Morphology and Tectonic Nature of Abyssal Trenches in Oceans and the 'Benioff Zones' Problem"]

[Abstract] On the basis of data in the literature the author gives a description of the structure and morphology of abyssal trenches associated with island arcs. According to widely held opinion, these trenches represent a projection of the so-called "Benioff zone" or subduction zone onto the ocean floor; in this zone there is a predominance of compression in the crust and a plate of the oceanic lithosphere is sucked into this zone. The data presented in this paper concerning the grabenlike form of the abyssal trenches, the positioning of earthquake foci beneath their floors and under the external slopes, as well as the uncertainty in determining the orientation of discontinuities in earthquake foci makes it possible to insist on the need for modernization of the concept of "Benioff zones," taking all the new data into account. Even if the problem is solved using mechanical models with pre-stipulated physical properties, it is difficult to visualize how one and the same volume of the lithosphere can be characterized both by the dilatational forces forming the grabens of abyssal trenches and compressional forces responsible for introducing undeformed Cenozoic sediments into the "Benioff zones." Examination of these "zones" on the basis of real data, rather than using schematic profiles and block diagrams, makes clear the invalidity of the hypothesis of "plate tectonics" not only in this special case, but also in more general variants.

[427]

PETROLEUM AND GAS ACCUMULATION IN CASPIAN DEPRESSION

Moscow NEFTEGAZOVAYA GEOLOGIYA I GEOFIZIKA in Russian No 4, 1979 pp 16-19

[Article by S. B. Kochar'yants, V. A. Zor'kina, V. V. Lipatova and U. Akchulakov, "Principal Zones of Petroleum and Gas Accumulation in the Above-Salt Complex of the Caspian Depression"]

[Abstract] In order to differentiate the territory of the Caspian depression on the basis of the degree of prospects of the above-salt complex the authors of this study carried out complex investigations, including lithological-facies, hydrogeological, paleohydrodynamic, geochemical, etc. It was established that for all the strata bearing petroleum and gas (Triassic, Jurassic, Lower Cretaceous) it is the southern, southeastern and eastern parts of the basin which are most promising with respect to all indices. Figure 1 in the text is a map of tectonic regionalization of the Caspian depression; Figure 2 is a map of zones of petroleum and gas accumulation in the above-salt complex in the Caspian depression. These maps serve as a basis for much of the textual discussion. In the remaining central part of the Caspian depression the Upper Permian-Triassic deposits lie at considerable depths. The absence of good collectors, intensive manifestation of salt tectonics and pre-Pliocene erosion do not make it possible to consider this region of any priority for reconnaissance and exploration work.

[438]

DETECTION OF ZONES OF ANOMALOUSLY HIGH STRATUM PRESSURES

Moscow NEFTEGAZOVAYA GEOLOGIYA I GEOFIZIKA in Russian No 4, 1979 pp 25-29

[Article by V. E. Dzhimiyev, G. B. D'yakonov, I. B. Krylov and A. I. Luginets, "Discrimination of Zones of Anomally High Pressure Using Data from Vibroseismic Prospecting"]

[Abstract] The existence of zones of anomalously high stratum pressures (AHSP) complicates the carrying out of drilling work and the exploitation of deposits of petroleum and gas. Therefore, in planning boreholes it is important to predict the depths of zones of AHSP and estimate stratum pressures prior to drilling. In this paper the authors examine the possibilities of discriminating zones of AHSP on the basis of vibroseismic sounding carried out in the West Kuban downwarp. It was found that the effectiveness of use of seismic prospecting in solving problems in the prediction of zones of AHSP is not dependent on the type of excitation source used, but is determined for the most part by the quality of the collected material. The accuracy in determining effective and stratum velocities with both excitation methods is inadequate for obtaining reliable quantitative estimates

of differential pressures and coefficients of anomalous behavior comparable with data from exploratory geophysical investigations and direct measurements of stratum pressures. An increase in the reliability of determining velocities from vibroseismic reconnaissance involves an improvement in the signal-to-noise ratio when carrying out field work. This will require use of a group of vibration sources, a great number of seismographs in the group and a decrease in the quantization interval during registry.
[438]

EFFECT OF MAGNETIC FIELD CHANGES ON OBSERVED GEOMAGNETIC ANOMALIES

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 19, No 3, 1979 pp 576-579

[Article by L. G. Kas'yanenko, Leningrad Division, Institute of Terrestrial Magnetism, Aeronomy and Radio Wave Propagation, "Influence of Changes in the Earth's Magnetic Field on Observed Geomagnetic Anomalies"]

[Abstract] An effort was made to determine the influence of changes in the interplanetary magnetic field on geomagnetic anomalies from geological bodies (or other sources) and to ascertain whether it is of practical importance for the purposes of geophysical interpretation. In order to solve this problem it was necessary to have some idea about the relationships between the spatial change of the interplanetary magnetic field with time over the area of the anomaly and the amplitude of the geomagnetic anomaly. It is evident that the greater the area occupied by a geomagnetic anomaly and the lesser its amplitude, the greater will be the contribution of changes in the interplanetary magnetic field to the observed characteristics of the geomagnetic anomaly. Figure 2 in the text is a world map of total changes in the T field over a period of 40 years. The map shows that the maximum distortions in the discriminating of anomalies of a large area and small amplitude must be expected in the equatorial and southern parts of Africa and in the neighborhood of Madagascar. It is shown that changes in the earth's geomagnetic field exert an influence on the measured geomagnetic anomalies, imparting to their characteristics (amplitude, phase, linear dimensions) an uncertainty in time. Thus, the "true" magnetic field from a geological body always remains unknown. In order to evaluate the temporal variability of anomalies it is necessary to have information on the spatial-temporal gradients of change in the interplanetary magnetic field. Regardless of how any anomalous magnetic field is discriminated it must be assigned to a temporal epoch.

[449]

IV. UPPER ATMOSPHERE AND SPACE RESEARCH

News

TASS ANNOUNCES LAUNCHING OF "COSMOS-1111"

Moscow TASS in English 1204 GMT 30 Jun 79

[TASS Report]

[Abstract] The artificial earth satellite "Cosmos-1111" was launched in the Soviet Union on 29 June 1979. The satellite was inserted into an orbit with the following parameters:

- initial period, 90.4 minutes;
- apogee, 353 kilometers;
- perigee, 264 kilometers;
- orbital inclination, 63 degrees. [5]

[439]

TASS ANNOUNCES LAUNCHING OF "COSMOS-1112"

Moscow TASS International Service in Russian 1458 GMT 6 Jul 79

[TASS Report]

[Abstract] The artificial earth satellite "Cosmos-1112" was launched in the Soviet Union on 6 July 1979. The satellite was inserted into an orbit with the following parameters:

- initial period, 93.4 minutes;
- apogee, 552 kilometers;
- perigee, 345 kilometers;
- orbital inclination, 50.7 degrees. [5]

[440]

TASS ANNOUNCES LAUNCHING OF GORIZONT COMMOSAT

Moscow TASS International Service in Russian 1522 GMT 6 Jul 79

[TASS Report]

[Abstract] A "Gorizont" communications satellite was launched in the Soviet Union on 6 July 1979 in accordance with the program to develop communication and television broadcasting systems. The "Gorizont" series is designed to provide television coverage of the 1980 Olympic Games in Moscow.

The satellite was inserted into a near-stationary orbit with the following parameters:

- distance from the earth's surface, 36,550 kilometers;
- orbital period, 24 hours 37 minutes;
- inclination, 0.8 degree. [5]

[442]

TASS ANNOUNCES LAUNCHING OF "COSMOS-1113"

Moscow TASS in English 1420 GMT 10 Jul 79

[TASS Report]

[Abstract] The artificial earth satellite "Cosmos-1113" was launched in the Soviet Union on 10 July 1979. The satellite was inserted into an orbit with the following parameters:

- initial period, 89.5 minutes;
- apogee, 350 kilometers;
- perigee, 180 kilometers;
- orbital inclination, 65 degrees. [5]

[445]

TASS ANNOUNCES LAUNCHING OF "COSMOS-1114"

Moscow TASS in English 0725 GMT 12 Jul 79

[TASS Report]

[Abstract] The artificial earth satellite "Cosmos-1114" was launched in the Soviet Union on 11 July 1979. The satellite was inserted into an orbit with the following parameters:

- initial period, 95.2 minutes;
- apogee, 558 kilometers;

-- perigee, 507 kilometers;
-- orbital inclination, 74 degrees. [5]
[446]

SG-R MAGNETOMETER ON BOARD "INTERCOSMOS-18"

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Jun 79 p 4

[Unsigned article]

[Text] "Intercosmos-18," which was launched in late 1978, was equipped with an "SG-R" magnetometer. Associates of the Romanian State Nuclear Energy Committee's Institute of Nuclear Physics and Engineering developed the magnetometer in collaboration with Soviet specialists. The instrument, which is built on analog and digital integrated circuits, is characterized by compactness, light weight and low energy consumption. It consists of two blocks -- a detector block, which was developed by Soviet scientists, and an electronic measuring block, which was created within the framework of a program coordinated by the Romanian Commission on Space Activity. The instrument, which makes it possible to measure the vector of the earth's magnetic field with high precision along three axes, has been highly praised by specialists. [5]
[447]

"SOYUZ-32" PREPARED FOR DESCENT

Moscow PRAVDA in Russian 16 Jun 79 p 6

[Article by A. Pokrovskiy: "They Changed Transport Ships and Docking Compartments"]

[Text] If we were to speak briefly, the actions of Vladimir Lyakhov and Valeriy Ryumin on these days can be reduced to two operations -- they have changed ships and changed its dock. But here at the Control Center, when step after step you trace the actions of the crew, you see what an enormous volume of work has fallen to their lot. Moreover, much must be done for the first time, because for the first time in orbit an unmanned ship has been transformed into a manned ship and vice versa.

"We have calculated," summarizes the Deputy Flight Director V. D. Blagov, "that the 'Protony' have more than twice fulfilled their usual daily norm, reducing the times allocated for eating and physical exercises. And, of course, due to their excellent knowledge of technology and good humor.

It is understandable that first of all the "Protony" unloaded the "Soyuz-34." And then came the time for being completely involved with the ship which had put them into orbit.

The "Soyuz-32" is a sort of record-setter among transport ships. It is the only one to have been in orbit for 109 days. And since this was a record, the designers very much wanted with their own eyes to confirm how their wards were doing in circumterrestrial space so that they could draw additional conclusions concerning their possibilities.

"But the 'Soyuz-32' descent module brought to earth not only this information," continues V. D. Blagov, "Scientists have received the results of experiments carried out by the 'Protony' in orbit. Including about thirty ampules with melts obtained under a state of weightlessness, kilometers of films from still and motion picture cameras, the results of experiments prepared by Bulgarian specialists, containers with biological objects and even molds of the pits discovered on one of the docking units, possibly inflicted by a meteorite. And a total of 180 'standard' kilograms of cargo. But since the 'Soyuz-32' was intended for manned flight, to compensate for their weight, directly in their seats, V. Lyakhov and V. Ryumin sent us an additional 'present,' very important for us. For the first time during the entire period of space flights we could hold in our hands a number of instruments which had never before been returned to the earth."

"The list of returned instruments was extremely diversified. For example, specialists were able to take apart the clock on the central control panel which operated for 600 days instead of the guaranteed 100. And they were able to study illumination lamps, which, on the contrary, did not last as long as expected. It was very interesting to examine the contents of the vacuum bags and the filter for harmful impurities."

"But in order for the descent module to arrive in good shape at the landing site, it was necessary to simulate the presence of a crew aboard it; after all, the 'Soyuz-32' was intended for manned flight and not all the operations aboard it could be accomplished by command from the earth. This part of the work of V. Lyakhov and V. Ryumin was completed, and it is now clear, also successfully. Using the control panel intended for locking at the time of emergence of the cosmonauts into open space, they checked the tightness of the descent module hatch, ahead of time initiated some programs, including the radio communication apparatus program. Finally, they transported into the station individual gear, emergency untouchable stores, documents and portable navigation instruments. And only then came the time to say 'farewell' to the 'Soyuz-32'."

"It is understandable that the 'Protony' desired once again to see how the ship which had put them into orbit, the ship with which they had worked in space for over three months, moved away for return toward the planet earth. Therefore, the cosmonauts asked the Center for permission so to orient the station that they could longer observe the flight of the 'Soyuz-32' from the windows."

"You know how precious fuel is," objected the Flight Director A. S. Yeliseyev.

"We've calculated all that... We only need four impulses, a small expenditure, and we'll economize on other operations."

There was no need to wait long for other operations. On the morning of the next day the "Protony" partially mothballed the station, moved into the ship, donned their spacesuits and closed the transfer hatches between the "Salyut-6" and the "Soyuz-34." They had to transfer the ship to the other docking unit in order to free the "assembly" compartment through which the station is supplied with fuel.

And now again we see a familiar picture on the screen: two artificial bodies slowly part in infinite space. But this time the distance between them is about a hundred meters -- fuel must be saved and there is no need for excessive risk. Such a distance is adequate for the station to be turned about its axis by command from the earth and moved to the required docking unit. And once again we heard the voices of the "Protony": "There is contact!"

It is unimportant from where the launching has taken place -- from a cosmodrome or from orbit: all the operations involved in bringing together the celestial objects and checking the tightness must be repeated very carefully. Only late on the evening of 14 June were the hatches opened and V. Lyakhov and V. Ryumin again entered the station through another -- transfer -- compartment. They entered in order to continue the flight.

[433]

"PROGRESS-7" DELIVERS NEW EQUIPMENT TO "SALYUT"

Moscow TRUD in Russian 3 Jul 79 p 4

[Article by I. Melenevskiy: "All Docking Units are Occupied"]

[Excerpt] And the work on transporting freight from the "Progress" to the station, already so familiar for cosmonauts, began aboard the orbital complex. The freighter brought them a little more than 1,300 kilograms of cargo. With the assistance of our constant guide at the Flight Control Center, the Deputy Flight Director Viktor Dmitriyevich Blagov, we in a sense glanced into the stacks and containers of the "Progress-7" and became familiar with their contents.

As usual, a freighter delivered into orbit air for freshening the station atmosphere -- 46 kilograms of pure air. If it is taken into account that a kilogram of air is a volume of about a cubic meter, this means that the station has received a supply for renewing approximately half of its atmospheric volume. Another traditional item of freight is fuel for refueling of the

combined engine. A total of a half-ton.

Regenerators of oxygen, water and food are all components of the so-called life support system and on all preceding occasions were sent in the volume which was required for normal maintenance of the life of the crew in orbit. In containers with food supplies, in addition to ordinary food, constituting the ration for the cosmonauts, there are food products which take into account the wishes of the "Protony." These include tins with sweet and sour meat (it is particularly selected in accordance with their taste), soluble tea and coffee, fresh garlic and onion.

The space complex was sent melts for experiments and also seeds and even several slips. The "Protony" immediately plant them in the "Oasis," an instrument arriving in the "Soyuz-34." This is an unusual greenhouse in which biological conditions necessary for the life of plants are created. The experiment is not new, but its results in every case are of great interest to specialists.

Among the freight which up to now had not been sent to the orbital station are the "Isparitel'" ("Evaporator") and "Soprotivleniye" ("Resistance") instruments and also the latest radio apparatus. Using the first instrument, a very thin coating is applied to the surface of the metals. This is done in the locking chamber in a vacuum. The cosmonauts will control operations from a control panel. The very thin, uniform spraying, of aluminum, for example, on a metal plate is accomplished rather rapidly with the "Isparitel'." Such materials are required for creating heat-regulating surfaces. The layer produced by means of the "Isparitel'" makes it possible to regulate the reflection of the sun's rays from the station's surfaces in the necessary direction.

The "Soprotivleniye" is in the class of instruments making it possible to carry out very precise measurements. Thus, on the basis of many characteristics it is possible to measure the process of microbraking of the station during its docking with the "Progress." This information is of particular interest to specialists in the field of ballistics. Now the space complex is situated in orbit at an altitude of somewhere between 370 and 350 kilometers. And its orbit is gradually decreasing. And it is very important that specialists precisely compute all the parameters of the ballistic coefficient, which influences a decrease in the orbit of the space complex. And the "Soprotivleniye" instrument will serve as a good support for this.

[443]

TASS ANNOUNCES LAUNCHING OF "COSMOS-1115"

Moscow TASS in English 1426 GMT 13 Jul 79

[TASS Report]

[Abstract] The artificial earth satellite "Cosmos-1115" was launched in the Soviet Union on 13 July 1979. The satellite was inserted into an orbit with the following parameters:

- initial period, 89.1 minutes;
- apogee, 263 kilometers;
- perigee, 222 kilometers;
- orbital inclination, 81.4 degrees. [5]

[448]

Translations

OBSERVATIONS OF ATMOSPHERIC DUST FROM SPACE

Moscow NAUKA I ZHIZN' in Russian No 6, 1979 pp 88-92

[Article by Doctor of Physical and Mathematical Sciences Al. Grigor'yev and Corresponding Member USSR Academy of Sciences K. Kondrat'yev]

[Text] Powerful dust storms constitute a global atmospheric phenomenon whose role in the overall contamination of the atmosphere has been clearly underevaluated. Only data obtained from space make it possible to understand the true importance of this natural phenomenon.

The scales of man's economic activity, the mastery of the world ocean and inaccessible regions of the continents, navigation in the high latitudes, supersonic aircraft air lines, and the development of long-distance transportation, increasing with each passing year, require more and more complete, diversified and routine information on the state of the environment.

Another aspect of this problem is that under the influence of man's ever-broadening economic activity changes are transpiring in the environment. In some cases these are appreciable even on a global scale. Thus, the need has arisen for regular monitoring of these changes and evaluating their possible effects. There is need for scientific prediction.

More and more forecasts are appearing. Among them there are more than a few which must be regarded as speculative. These include predictions of rapid catastrophic changes in climate and talk about the death of everything living on the earth as a result of supersonic aircraft destroying the ozone layer in the stratosphere which protects us against the destructive effect of hard UV solar radiation. These predictions are without proof; they are based on models of the considered phenomena which are too simplified and which do not reflect reality. The serious theoretical investigations made during recent years refute the possibility of the above-mentioned catastrophes. However, the necessity of rigorous and regular monitoring of ecological conditions (state of the environment) on a global scale has become clearer than ever before.

The principal difficulties in preparing a reliable prediction of those agents which can cause changes in the environment are not only the fact that it is necessary to take into account an enormous number of diverse factors, but also that the necessary information is lacking on different parameters of the environment. For example, one of the important factors in modern changes in climate is that there is an increase in the dust content in the atmosphere. For the time being it is impossible to predict how this phenomenon will develop and to what the consequences will lead. There are no data on the global distribution of dust content of the atmosphere and the properties of dust under different conditions.

Observations from space have opened a new stage in the study of atmospheric dust and especially powerful dust storms. Dust and dust-sand storms constitute a phenomenon which occurs widely in regions with an arid climate. Man has had to contend with the frightful force of this natural phenomenon since long ago. We know of a case (mentioned by Herodotus) when a dust storm in the desert overtook an army and the entire army perished. Even in antiquity people noted that dust storms occur most frequently in places where the fields are plowed year after year in one and the same place or in places where the land is trod down by animals around settlements and cities.

Some modern researchers (especially the climatologist R. Bryson) feel that the demise of many ancient cities surrounded by the desert was associated with the development of a great dust content in the atmosphere.

Dust was raised in large quantities and accumulated in the atmosphere from soil deprived of vegetation. This became one of the reasons for a climatic change. Once fertile lands were transformed into desert.

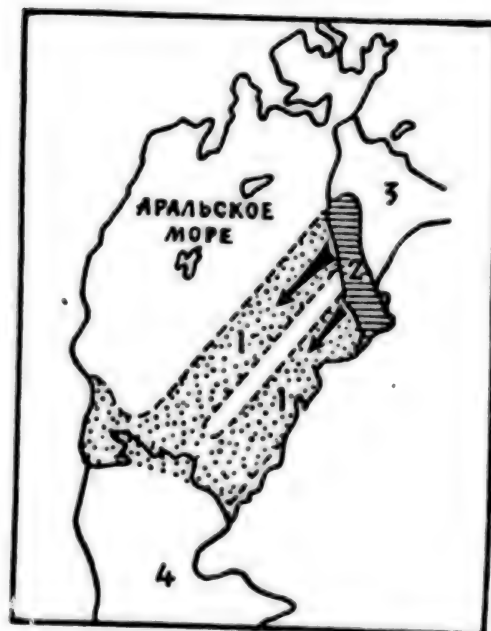
Powerful dust storms in actuality considerably contaminate the atmosphere, changing its optical properties. This exerts an influence on climate. In our time, especially during the last decade, the concentrations of dust in the atmosphere have been tracked by meteorologists, specialists in physics of the atmosphere, climatologists and other specialists.

Observations from space have yielded unique new data on the distribution, extent, dynamics and evolution of dust clouds, their structure, foci of formation and dependence on the properties of the earth's surface.

When observing the change in the color of the twilight sky specialists made a qualitative analysis of the vertical distribution of different optically active components of the earth's atmosphere, and in particular, atmospheric aerosol (atmospheric dust).

It was found that atmospheric aerosol most frequently has a layered structure. It is easy to see layers at an altitude of 10-15 km, and at the level of the so-called Junge layer (20 km), and at still greater altitudes. The discovery of aerosol layers helped in explaining the nature of

so-called "brightness layers" and "inversions of coloring of the twilight sky," discovered by cosmonauts.

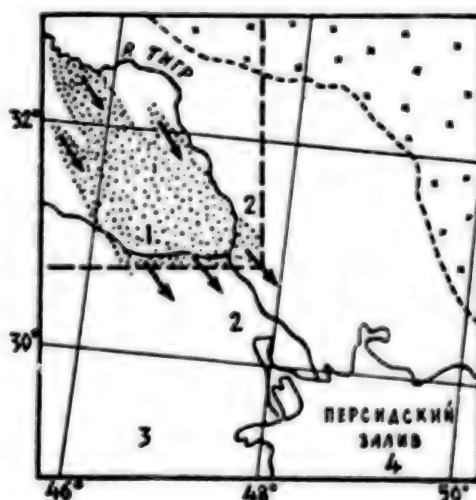


Left: Television image of a dust storm in the Aral Sea region, obtained on 22 May 1975 from the Soviet meteorological satellite "Meteor-18" in the near-IR spectral region ($0.8-1.1\mu\text{m}$) from an altitude of about 900 km. Right: Diagrammatic map of region of development of dust storm and its focus -- coastal shoals (former sea floor) forming during recent years as a result of a very marked decrease in sea level. 1 -- paths of dust storm, 2 -- sandy coastal shoals, 3 -- delta of Syr-Dar'ya River, 4 -- delta of Amu-Dar'ya River.

And this knowledge was extremely important for space navigation. The accuracy in orienting a spaceship relative to the earth is related to a knowledge of the optical properties of the atmosphere. The peculiarities of decrease in atmospheric brightness near the earth's limb and the structure of the space horizon of the planet are caused primarily by the properties and spatial distribution of atmospheric aerosol.

Observations from space have made it possible to obtain unique data on the propagation of dust storms. They have made it possible to determine the locations of powerful dust storms in the atmosphere (the places where they are formed). The cosmonaut G. T. Beregovoy, for example, observed the development of a dust storm in the region of the Arabian Peninsula.

Surveys from space revealed three regions of the most active development of dust storms over the territory of the USSR: over the waters of the northern part and the northeastern shores of the Caspian Sea, over the waters of the southern part and the southeastern shores of the Caspian Sea, over the waters and northeastern shores of the Aral Sea. Here the dust sources are the deserts of Central Asia and the steppes of Kazakhstan.



Left: Television image of dust storm in Mesopotamia obtained on 12 August 1968 from the Soviet meteorological satellite "Cosmos-226" from an altitude of about 625 km. It is easy to see three major paths of dust drift within which smaller drifts can be distinguished.

Right: Diagrammatic map of region of dust storm development. 1 -- dust cloud, 2 -- Mesopotamian lowland, 3 -- desert, 4 -- gulf waters.

In southern Asia, as indicated by observations from space, dust clouds appear most frequently over the Mesopotamian Lowland and are associated with the Northwesterly Trades. In fact, the most powerful dust storms on the planet are observed in Africa over the western Sahara and the adjacent waters of the Atlantic.

The photographs taken from space help in tracing the trajectories of movement of dust clouds. For example, using space photographs it was found that the dust transported from the northeastern shores of the Aral Sea (usually during the passage of a cold front) moves over the sea surface and often falls in the area of the lower reach of the Amu-Dar'ya River, causing salinization of the fertile lands.

As indicated by the trajectories of motion of dust clouds observed from space, in many cases the trajectories pass from continent to continent. For example, the dust from the deserts of North Africa is transported by cyclones across the Mediterranean Sea to the shores of Europe, and from

East Africa (by monsoons) across the Red Sea into Asia.

The enormous masses of dust entrained by the Trade Winds move from the Sahara to the west, in the direction of the Atlantic. Precisely here, as demonstrated by observations from space, one finds the most extensive -- transcontinental (length more than 6,000 km) trajectories of dust movement in the atmosphere from the Western Sahara to the shores of North, Central and South America.

It is interesting that long before extensive space research began the American scientist A. Prospero, in examining samples of reddish dust, falling near the Barbados, stated that its only source could be the Sahara. Such a superdistant movement of dust seemed improbable to many.

An analysis of space images confirmed that enormous anticyclonic eddies in actuality transport dust across the ocean. This phenomenon, accompanied by the formation of a so-called Sahara aerosol layer, was investigated in detail several years ago, during the period of the Atlantic Tropical Experiment, carried out within the framework of the Program for Investigation of Global Atmospheric Processes (GARP). For this purpose use was made of both images of the earth from space (meteorological satellites in polar and geostationary orbits) and data from ground, shipboard and aircraft observations.

The great coverage of space photographs (from tens of thousands to tens of millions of square kilometers), on which are imprinted individual large regions of the earth, entire continents and even the entire visible disk of the earth (photographs from geostationary satellites), for the first time made it possible to obtain a real idea concerning the real extent of dust clouds. These photographs can be used in tracing dust clouds with an extent from tens of kilometers (similar clouds can be observed from the earth's surface) to hundreds and even thousands of kilometers. No one suspected the existence of dust clouds with an extent of hundreds and thousands of kilometers and therefore this was a real discovery.

Dust storms in the Aral Sea region usually attain a length of 200-400 km. In the region of the Mesopotamian Lowland more significant dust clouds with an extent up to 500-800 km are formed. But the largest dust clouds, as we have already mentioned, were discovered over Africa and the Atlantic. These clouds extend for a distance from 800-1,000 to 4,500-5,000 km. A dust cloud of unique extent, with an area of about 6 million square kilometers, was discovered by a survey from space on 30 June 1974 over the Atlantic and western Africa.

Observations of dust clouds from space made it possible to detect new, earlier unknown peculiarities of their macrostructure. It is impossible to judge the elements of macrostructure of dust clouds on the basis of observations from the earth's surface: the coverage is too small. It is easier to do this from an aircraft which rises to an altitude of 3-8 km

over the dust cloud but, unfortunately, such observations are only of a sporadic nature. An analysis of the images obtained from space revealed that for many dust storms of the "drift" type there is characteristically a streamlike macrostructure. A dust flow most frequently is not an integrated whole but is broken down into several streams. On space photographs dust streams are visible in the form of bands which are particularly clearly visible when the dust cloud passes over water (over a dark underlying surface).

The space photograph which is reproduced here shows a dust storm over the Aral Sea. Over the dark water surface one can clearly see (at the bottom right) two light-colored large dust streams, each with a width of 30-40 km. The separation of the dust cloud into two large streams in this region is attributable to the peculiarities of relief of the coastal shoal where the dust stream begins.

Where and why are powerful dust clouds formed? What favors their development? It must be said that earlier dust clouds were investigated primarily in the region where the dust fell, that is, far (in many cases hundreds and even thousands of kilometers) from the place of dust origin. Only guesses were made concerning the origin of the falling dust. Many cases are known, for example, when red or brown dust falls in Western Europe (in the Alps), in the territory of the USSR (for example, in February 1972 in Novgorodskaya Oblast) and in different regions along the eastern shores of Central America.

Photographs from space make it possible to see the dust cloud itself and its focus at the same time. An analysis of the photographs taken from satellites unquestionably shows that in all the mentioned cases the Sahara was the dust source.

By comparing photographs at different scales it was possible to detect earlier unknown dust storm foci in the Atlantic, situated in different regions of the Western Sahara, on the northeastern and southeastern shores of the Caspian Sea, and on the northeastern shores of the Aral Sea.

Judging from data from an analysis of successive space photographs, the foci of dust storms in the Aral Sea developed recently. This is a result of a considerable (by several meters) decrease in sea level caused by both natural (climatic) and anthropogenic (intensive withdrawal of water from the Amu-Dar'ya and Syr-Dar'ya Rivers for the needs of irrigation) factors. A shoal consisting of unconsolidated fine pulverized sands was formed in the northeastern part of the Aral Sea. The dust storms forming here became noticeable from space.

A dust cloud was photographed over the territory of the United States on 24 February from the meteorological satellite "NOAA-5." It extended for 2,400 km from Albuquerque, New Mexico, to the Gulf of Mexico. Such a major dust storm had not been observed here since the 1930's, unhappily remembered

for the maximum development of dust storms inflicting enormous harm on the economy of the United States. This is an alarm signal.

The dynamics of powerful dust storms is still poorly studied. These studies are only beginning. Space photographs obtained with frequent periodicity will help in studying the velocity of movement of dust clouds, the periodicity of their appearance and the peculiarities of their movement. For example, observations from space revealed that in the Aral Sea region powerful dust storms occur 6-9 times a year, during the course of two periods -- from April through June and from August through September.

The intensity of these dust storms and their role in the general contamination of the atmosphere have until now been underevaluated. Investigations carried out from space have made it possible to understand the true importance of this natural phenomenon. Specialists for the first time have tried to calculate the mass of atmospheric dust. The results were surprising. For example, in the Aral region alone the annual quantity of transported dust is 15-75 million tons.

But how to calculate how much dust is raised into the atmosphere? For approximate estimates use was made of the results of measurements of the brightness of the system "earth's surface-atmosphere" from satellites or data from ground measurements of visibility and atmospheric transparency.

Television images of the Caspian Lowland taken on 13 June 1970 at 1715 hours Moscow time from the "Meteor-4" meteorological satellite revealed a dust storm to the west of the Volga, in the Sal'skiye steppes; it had the form of a bright band measuring 450 x 250 km and extended in a meridional direction. In this band it was easy to see two zones of different atmospheric turbidity, in one range of visibility about 4 km, and in another -- 7-10 km. Aerological data have indicated that the upper boundary of the dust cloud is situated at an altitude of about 2 km. These data served as a basis for computing the mass of dust in the thickness of the atmosphere and the volume concentration of dust. It was found that the total mass of dust suspended in the atmosphere in the storm region was 1.4 million tons.

Observations and calculations indicate that the degree of brightness of the earth's surface (according to images from space) can serve as an indicator, an index of the optical thickness of the aerosol (dust) layer in the atmosphere.

Computation graphs were constructed of the linear correlation between the brightness of the "ocean surface-atmosphere" system and the aerosol content in the thickness of the atmosphere for different solar altitudes. According to these data, a change in aerosol content by 1.5% causes a brightness change by 1%.

The use of photometric measurements of negatives made it possible to construct brightness fields characterizing the optical properties of the atmosphere. If it is assumed that the blackening density is proportional

to aerosol scattering, it is easy, on the basis of the brightness distribution, to trace the dynamics of the aerosol, in particular, how the atmospheric dust precipitates during movement.

By evaluating data on how the total aerosol content in the atmosphere changes it is possible to determine the rate of precipitation of particles. An analysis of the relationship of brightness contrasts helped in determining the diameter of particles, etc.

Specialists feel that promising methods for reconstructing the vertical profile of the aerosol concentration include measurements of the brightness of the daytime and twilight horizons of the earth, and also attenuation of solar radiation by the thickness of the atmosphere at sunrise and sunset relative to the satellite. The first experiment with registry of the spectra of brightness of the twilight horizon was carried out by the cosmonaut Ye. V. Khrunov aboard the manned spaceship "Soyuz-5." Using an instrument making it possible to measure radiation at different wavelengths within the limits of the visible range, Ye. V. Khrunov obtained spectra of the earth's twilight aureole (in this case the spaceship is situated on the earth's nighttime side and the cosmonaut directs the instrument in the direction of that part of the horizon where the sun has just set and the atmospheric layer assumes the twilight glow).

Theoretical computations of brightness of the twilight aureole have shown that the change in brightness of the atmospheric layer with altitude is determined by atmospheric content of dust at different altitudes. Therefore, on the basis of data on the spectra of the aureole registered at different points on the earth it is possible to determine the spatial distribution of dust content.

Spectra of the daytime horizon can also be a source of information on atmospheric turbidity. Therefore, one of the problems in the scientific program carried out by the cosmonaut V. N. Volkov aboard the "Salyut-1" orbital station was the registry of spectra of the daytime horizon.

A peculiarity of the experiments for registry of spectra of both the twilight and daytime horizons is that they cannot be delegated to automatic instruments. The instrument can be properly oriented only by an experienced specialist. But cosmonauts are specially trained for carrying out such scientific experiments.

Methods for determining the dust content of the atmosphere on the basis of measurements from satellites are only now being developed. This work is unquestionably very promising. It helps in obtaining reliable information on the content and properties of dust in the earth's atmosphere. And this information is directly related to solution of many problems in the national economy.

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Abstracts of Scientific Articles

CONDITIONS FOR PROPAGATION OF DECAMETER RADIO WAVES

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 19, No 3, 1979 pp 474-482

[Article by L. A. Lobachevskiy, Kh. B. Soares, I. A. Tushentsova, D. I. Fishchuk and Ye. Ye. Tsedilina, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation and Institute of Geophysics and Astronomy Academy of Sciences Republic of Cuba, "Analysis of Conditions for the Propagation of Decameter Radio Waves on an Extended Path by the Adiabatic Method at a Fixed Frequency. I"]

[Abstract] In earlier studies (GEOMAGNETIZM I AERONOMIYA, 11, 961, 1971, 13, 233, 1973, 14, 1008, 1974) the authors developed a method (adiabatic invariant method) making it possible to compute the parameters of extensive radio paths, including around-the-earth paths. Now, on the basis of this method, the authors present computations and give a general analysis of the conditions for the propagation of radio waves at a fixed frequency $f = 10$ MHz on a path with a length of 9600 km with radiation at Nikolayev and reception at Havana. The results of the computations are compared with the results of corresponding experiments with slant sounding of the ionosphere along this path. It was possible to determine the dependence of the volumes of all possible channels on the local time of the mid-point of the path and the ratio of the working frequency to the maximum usable frequency. [449]

BOUNDARY REGION OF PLASMA LAYER IN NIGHTTIME SECTOR

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 19, No 3, 1979 pp 499-503

[Article by V. I. Lazarev and M. V. Tel'tsov, Nuclear Physics Institute, Moscow State University, "Boundary Region of Plasma Layer in Nighttime Sector According to Observations on the "Molniya-1" Artificial Earth Satellite"]

[Abstract] The dynamics of the inner boundary of the plasma layer in the nighttime sector of the magnetosphere was investigated during flights of the "Molniya-1" through this sector during June-July 1974. The satellite

carried a two-channel electrostatic spectrometer making it possible to measure the differential streams of electrons and protons with energies 2, 5, 11, 15 and 19.5 KeV. A comparison of these results with data from magnetic stations shows that the development of disturbance in the polar region is associated with the movement of the region of the auroral boundary toward the earth. The appearance of plasma at definite L-shells during a magnetic storm corresponds to the region of invariant latitudes at which there is a decrease in the magnetic field; an increase in these streams causes a great field decrease. An analysis of 25 flights of the "Molniya-1" through the plasma zone in June-July 1974 made it possible to obtain a correlation between the inner boundary of the plasma layer and the K_p index, including data during a strong magnetic storm. The K_p index is evidently too approximate a measure of the correlation between magnetic conditions and the position of the auroral boundary.

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INTERFERENCE OF DECAMETER RADIO WAVES NEAR THE ANTIPODE

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 19, No 3, 1979 pp 470-473

[Article by I. S. Vsekhsvyatskaya and Yu. K. Kalinin, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, "Interference of Decameter Radio Waves Near the Antipode"]

[Abstract] In earlier studies a number of authors have proposed geometro-optical focusing models whose investigation requires the construction of ray trajectories over extended paths (under real and idealized conditions). The authors have now developed a variant of a method for modeling the antipodal focusing effect not requiring the construction of ray trajectories. Known experimental data on the size of the focusing spot of energy of decameter radio waves near the antipode are interpreted on the basis of the analysis made here to be a result of the random interference of wave packets propagating in different azimuths.

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V. MISCELLANEOUS

News

"SP-24" CONTINUES EXPEDITION

Moscow PRAVDA in Russian 24 Jun 79 p 3

[TASS Report: "'SP-24': One Year in the Arctic"]

[Text] One thousand kilometers away from their starting point in the Arctic Ocean, polar explorers on the "Severnny Polyus-24" drifting scientific station marked one year since raising the USSR flag over the frozen island.

This new outpost of Soviet polar science was established, as you know, during the high-latitude experimental cruise of the atomic icebreaker "Sibir". Here a small scientific community with an extensive complex of observation posts and laboratories was created. At the present time the station is located at latitude 82° and is drifting toward the geographical north pole.

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ARCTIC CARGO HAULAGE

Khabarovsk Domestic Service in Russian 0930 GMT 4 Jun 79

[Brief] Another route will be opened this week from Vanino port. Cargo is presently being loaded on the motorship "Vitya Khomeko." The ship will open navigation to the coast of the Arctic Ocean by delivering several thousand tons of cargo to geologists and construction workers of Cape Schmidt.

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NOTES FROM ARCTIC AND ANTARCTIC RESEARCH INSTITUTE

Moscow World Service in English 2230 GMT 8 Jun 79

[Brief] The main facilities of the Arctic and Antarctic Institute in Leningrad are not in Leningrad. They are aboard a number of ships cruising regularly in the polar seas and are installed in scientific stations set up on the islands and drifting icefields of the Arctic and at Soviet stations at several points in the Antarctic region. The discovery of a vast wealth of mineral resources within the polar circle during the years of Soviet rule has produced new cities and large industrial enterprises. Now, in addition to research vessels and airborne expeditions there are two drifting scientific stations in the Arctic: the Severnyy Polyus-22 and the Severnyy Polyus-24. The stations are actually well-equipped settlements with comfortable living quarters and the latest scientific instruments. Lev Blatov, the head of the Severnyy Polyus-22 station, said that the station had drifted and had covered 1,000 km in one year. In addition to meteorological, oceanological and geophysical work, studies were made of the optical properties of the atmosphere, the degree of pollution of the Arctic Ocean and changes in the earth's magnetic field.

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Abstracts of Scientific Articles

PAST AND FUTURE OF ANTARCTIC GLACIATION

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 5, GEOGRAFIYA in Russian
No 3, 1979 pp 11-18

[Article by S. M. Myagkov, Problems Laboratory on Avalanches and Mudflows,
Moscow State University, "Past and Future of Antarctic Glaciation"]

[Abstract] The information accumulated during 80 years of study of Antarctica has now made it possible to give an overview of the entire history of Antarctic glaciation. This article reviews the reasons for onset of the glaciation, climatic influence and stability of the Antarctic polar glaciation, factors controlling the extent of the Antarctic glaciation and periods in its history, and prediction of evolution of Antarctic glaciation. It is noted that some feel that there can be a rapid destruction of the West Antarctica part of the ice sheet as a result of the technogenic increase in CO₂ content in the atmosphere and a corresponding climatic warming. The data presented here show that such a warming is possible. In actuality, it can lead to a marked reduction in the Ross Ice Shelf, although possibly not to its complete disappearance. However, it is unclear whether there will be destruction of the West Antarctica ice cover or how rapid this might be. It is therefore necessary to make a thorough study of the problem of the reaction of the West Antarctica glaciation to technogenic climatic changes. It is emphasized that this and other problems in Antarctic glaciation cannot be solved with the current level of organization of research. It is clear that polar and middle latitude continental glaciations must be regarded as glaciations of two different types which differ substantially with respect to conditions of formation and controlling factors. Therefore, they differ with respect to influence on planetary climate, degree of stability, lifetime and other characteristics, but it is possible that they are identically sensitive to technogenic climatic changes.
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